13, 2017 at 12:47 pm EDT

VLA Gives New Insight Into Galaxy Cluster's Spectacular "Mini-Halo"

Credit: Gendron-Marsolais et al.; NRAO/AUI/NSF; NASA; SDSS.

Astronomers using the National Science Foundation's Karl G. Jansky Very Large Array (VLA) have discovered new details that are helping them decipher the mystery of how giant radio-emitting structures are formed at the center of a cluster of galaxies.

The scientists studied a cluster of thousands of galaxies more than 250 million light-years from Earth, named the Perseus Cluster after the constellation in which it appears. Embedded within the center, the Perseus Cluster hosts a pool of superfast particles that emit radio waves, creating a radio structure known as a "mini-halo." Mini-haloes have been found in

Images & Videos

about 30 galaxy clusters, but the halo in
known, about 1.3 million light-years in di
Milky Way Galaxy.

The sizes of the mini-haloes have presented a puzzle to astronomers. As the particles travel away from the cluster's center, they should slow down and stop emitting radio waves long before they reach the distances observed, according to theory.

"At large distances from the central galaxy, we don't expect to be able to see these haloes," said Marie-Lou Gendron-Marsolais, of the University of Montreal. "However, we do see them and we want to know why," she added.

The astronomers took advantage of the upgraded capabilities of the VLA to make new images of the Perseus Cluster that were both more sensitive to fainter radio emissions and provided higher resolution than previous radio observations.

"The new VLA images provided an unprecedented view of the mini-halo by revealing a multitude of new structures within it," said Julie Hlavacek-Larrondo, also of the University of Montreal. "These structures tell us that the origin of the radio emission is not as simple as we thought," she said.

The new details indicate that the halo's radio emission is caused by complex mechanisms that vary throughout the cluster. As theorized before, some radio emission is caused by particles being reaccelerated when small groups of galaxies collide with the cluster and give the particles a gravitational shove. In addition, however, the scientists now think that the radio emission is also caused by the powerful jets of particles generated by the supermassive black hole at the core of the central galaxy that give an extra "kick" of energy to the particles.

"This would help explain the rich variety of complex structures that we see," Gendron-Marsolais said.

"The high-quality images that the upgraded VLA can produce will be key to helping us gain new insights into these mini-haloes in our quest to understand their origin," Hlavacek-Larrondo said.

The VLA, built during the 1970s, was equipped with all-new electronics to bring it up to the technological state of the art by a decade-long project completed in 2012. The images of the Perseus Cluster were made using a new low frequency receiver system funded by the Naval Research Laboratory (NRL) and built through collaboration between NRL and the National Radio Astronomy Observatory.

Gendron-Marsolais and Hlavacek-Larrondo, along with an international team of researchers, are reporting their findings in the *Monthly Notices* of the Royal Astronomical Society.

The National Radio Astronomy Observatory is a facility of the National Science Foundation, operated under cooperative agreement by Associated Universities, Inc.

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radio-emitting mini-halo in the Perseus Cluster of galaxies. Radio emission in red; optical in white.

Credit: Gendron-Marsolais et al.; NRAO/AUI/NSF; NASA; SDSS.

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This research is being published in a paper entitled, *Deep 230-470 MHz VLA observations of the mini-halo in the Perseus cluster*.

https://academic.oup.com/mnras/article-lookup/doi/10.1093/mnras/stx1042

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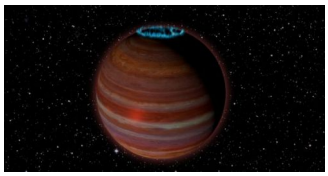
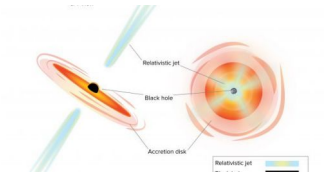


VLA Detects Possible Extrasolar Planetary-Mass Magnetic Powerhouse

August 2, 2018

Astronomers have used the VLA to detect a possible planetary-mass object with a surprisingly powerful magnetic field some 20 light-years from Earth. It can help scientists better understand magnetic processes on stars and planets.

(https://public.nrao.edu/news/vla-mass-powerhouse/)

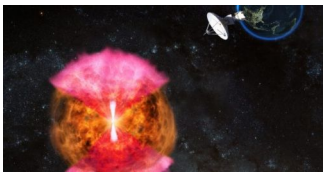


VLA Gives Tantalizing Clues About Source of Energetic Cosmic Neutrino

July 10, 2018

The track of an elusive, energetic neutrino points to a distant galaxy as its source and VLA observations suggest high-energy particles may be generated in superfast jets of material near the galaxy's core.

(https://public.nrao.edu/news/vla-cosmic-neutrino/)



Radio Observations Point to Likely Explanation for Neutron-Star Merger Phenomena

December 20, 2017

VLA observations have pointed to the most likely explanation for the phenomena that followed the violent collision of a pair of neutron stars in a galaxy 130 million light-years from Earth.

(https://public.nrao.edu/news/neutron-star-merger-phenomena/)

IMAGE RELEASE: Shocking Results of Galaxy-Cluster Collisions

November 7, 2017

A giant collision of galaxy clusters has produced a spectacular panorama of shocks and energy produced by the violent encounters.

(https://public.nrao.edu/release-galaxy-cluster-collisions/)

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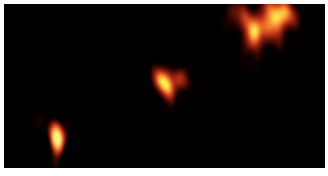

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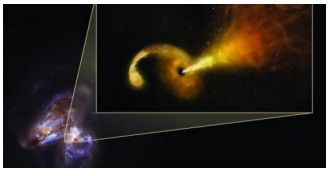

Astronomers See Distant Eruption as

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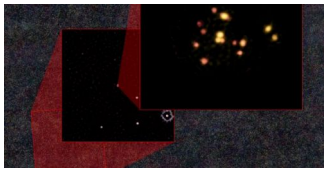

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July 6, 2018

The sharp radio "vision" of the VLBA gives astronomers a detailed look at a galaxy as it appeared when the Universe was a small fraction of its current age, giving clues about conditions at that early time.

(https://public.nrao.edu/news/distant-quasar-early-universe/)

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June 11, 2018

Years-long observation program surprises astronomers with evidence of a star's violent death near the core of a distant galaxy.

(https://public.nrao.edu/news/black-hole-destroys-star/)

signature of oxygen from galaxy 13.28 billion light-years away

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